

**Remarks/Arguments:**

Claims 1-18 were pending in the application. With this amendment, claims 11 and 12 are canceled. Claims 1-10 and 13-18 are therefore pending in the application.

Claims 1-5, 8, 10-15 and 17 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Japanese Patent No. 6-112261 ("JP '261"), U.S. Patent Application Publication No. 2002/0003389 ("Ishiguro") or U.S. Patent No. 6,885,135 ("Kanao"). Claims 1-18 stand rejected as obvious over Japanese Patent No. 2002-327266 ("JP '266") or Japanese Patent No. 10-259435 ("JP '435"). Claims 1, 2, 6, 8, 9, 11, 12, and 16-18 stand rejected on the grounds of nonstatutory obviousness-type double patenting as unpatentable over claims 1-16 of U.S. Patent No. 6,885,136 ("Orjela"). Applicants respectfully traverse the rejections and respectfully submit that the currently pending claims are patentable over the cited references for at least the reasons set forth below.

**RESPONSE TO OBVIOUSNESS REJECTIONS**

Independent claims 1, 2 and 3 are rejected based on JP '261, Ishiguro, Kanao, JP '266 and JP '435. As a preliminary matter, Applicants respectfully submit that JP '266 is not prior art to the instant application. Specifically, the publication date of JP '266 is November 15, 2002, which is after the priority date of July 13, 2002 of the instant application. The rejections based on JP '266 are therefore moot.

Regarding the remaining references, the Office asserts that each of the references discloses an iridium alloy having a composition with alloying constituents having overlapping weight percent ranges recited by the pending claims. The Office cites to Ishiguro in claims 15 and 16 on page 6, claim 10 of column 21 of Kanao, and the abstracts of JP '261 and JP '435 as support. The Office then alleges that this overlap of ranges establishes a *prima facie* case of obviousness because it would have been obvious "to select the claimed alloy weight percent ranges over the broader disclosure of the prior art since the prior art teaches the same utility."

With respect to what each of the references discloses, as cited and relied upon by the Office, Applicants include the following, as reproduced from the references:

Kanao

In claim 10, Kanao recites "wherein a material for said noble metallic tip is an iridium alloy containing Ir as a chief component and at least one additive component selected from the group consisting of Rh (50 weight% or less), Pt (50 weight% or less), Ni (40 weight% or less), W (30 weight% or less), Pd (40 weight% or less), Ru (30 weight% or less) and Os (20 weight% or less).

Ishiguro

In claim 15, Ishiguro recites "said Ir-alloy chip is made from material containing a main component of Ir (Iridium) and an additive of at least one of Rh (rhodium), Pt (platinum), Ru (ruthenium), Pd (palladium), and W (tungsten)."

In claim 16, Ishiguro recites "wherein said Ir-alloy chip contains 70 to 99 Wt % of Ir."

JP '261

In the abstract of JP '261, as translated, the reference recites "an Ir alloy which contains one kind or two or more kinds out of Os, Ru, Pt, Rh and Pd at a total amount of 1 to 30wt.%, which contains one kind or two or more kinds out of Re, W and Mo at a total amount of 0.1 to 7wt.% and which contains Ir as the remainder."

JP '435

In the abstract of JP '435, as translated, the reference recites "pure iridium as a base a secondary element composed of one kind among platinum, palladium, rhodium, niobium, tantalum, hafnium, titanium, zirconium, yttrium, lanthanum and molybdenum is added in the solid solution range by 0.1 to 50 wt.% or several kinds of the secondary elements one compositely added in the solid solution range by 0.1 to 50 wt.%, to obtain the iridium base alloy which attains strength at low temps. and high temps. and, furthermore, improves oxidation resistance and expansibility at high temps."

Applicants submit that although Kanao discloses devices containing Ir alloys that may contain Rh, Pt, Ni, W, Pd, Ru and Os, no specific examples of alloys are given. Moreover, no reasons are give why one of the listed constituents would be selected over any other constituent, much less why one of ordinary skill in the art would select the claimed alloys' constituents in the specifically claimed amounts. The only disclosure of an iridium alloy is that, as reproduced above, containing at least one alloy of Rh, Pt, Ni, W, Pd, Ru and Os. Of these, Rh, if selected, is present at 50% or less and W, if selected, is present at 30% or less. Applicants submit that one of ordinary skill in the art would not be driven to select the specific iridium alloy having 0.1 to 2.5 wt% Rh and W comprising between 0.01 and 5 wt% of the alloy based on this disclosure of Kanao.

Similarly, Ishiguro discloses devices containing Ir alloys containing at least one of Rh, Pt, Ru, Pd and W. Ishiguro, however, discloses only one example of an alloy, namely 90 wt% Ir + 10 wt% Rh. This also fails to disclose or suggest Applicants' claimed alloy having 0.1 to 2.5 wt% Rh and W comprising between 0.01 and 5 wt% of the alloy based on this disclosure of Ishiguro.

JP '435 includes Ir alloys containing a second element from Pt, Pd, Rh, Nb, Ta, Hf, Ti, Zr, Y, La and Mo, with examples of alloys given including: Ir/Pd, Ir/Ta, Ir/La, Ir/Ti, Ir/Rh/Pt, Ir/Rh/Ru, Ir/Rh/Re, Ir/Rh/Cr, Ir/Rh/V, Ir/Rh/V and Ir/Rh/Mo. Significantly, however, JP '435 fails to disclose any examples including a combination of Ir/Rh/Zr, and merely lists the addition of a second element to Ir in a broad concentration of 0.1 to 50%. Where a third element is disclosed, the third element is Ru, Cr, Va, and Mo. (See JP '435, claims 2 and 3 and paragraphs 6 and 7, for example). Neither Zr nor W are among those listed as the third element. Applicants submit that JP '435, therefore, fails to disclose or suggest Applicants' claimed iridium alloy having 0.1 to 2.5 wt% Rh and W comprising between 0.01 and 5 wt% of the alloy, nor any reason why one of ordinary skill in the art would modify JP '435 to obtain Applicants' claimed alloy.

Finally, JP '261 includes devices containing Ir alloys containing at least one of Os, Ru, Pt, Rh, Pd in amounts of 1-30 wt% and at least one of Re, W and Mo in amounts of 1-7 wt%. JP '261 further indicates that it is undesirable to include amounts above or below these ranges. (See paragraphs 10 and 11, respectively). Moreover, only one example of an alloy is given in JP '261, that of 99 wt% Ir + 1 wt% Rh. Again, Applicants submit that such disclosure fails to provide any example of the claimed alloys, nor reason that would drive one of ordinary skill in the art to select the specific iridium alloy claimed having 0.1 to 2.5 wt% Rh and W comprising between 0.01 and 5 wt% of the alloy.

Accordingly, Applicants submit that the lack of sufficiently specific disclosure in any of the cited references provides one of ordinary skill in the art no reason whatsoever to select the alloys specifically claimed by the Applicants. Moreover, what little teaching in the references of certain combinations of alloys would be more likely to lead one of ordinary skill in the art away from the claimed invention, not only with respect to the specific constituents, but also with

respect to the multitude of possible concentrations of the different combinations of components that could potentially be selected.

Applicants contend that the above-recited disclosures of the respective references cannot therefore form the basis of a *prima facie* obviousness rejection. Specifically, such broad disclosures encompass a very large number of possible distinct compositions, and presents a situation more analogous to the obviousness of a species where the prior art broadly discloses a genus. See M.P.E.P. § 2144.05 (citing *In re Peterson*, 315 F.3d 1325, 1330, 65 U.S.P.Q.2d 1379, 1382-83 (Fed. Cir. 2003)). Although *KSR* provides that the teaching, suggestion and motivation (TSM) test should not be rigidly applied, it still remains that to establish a *prima facie* case of obviousness in a genus-species chemical composition situation, there must be some motivation, suggestion or reason to make the claimed invention in light of the prior art teachings. See e.g. M.P.E.P. § 2144.08; see also *In re Brouwer*, 77 F.3d 422, 425, 37 USPQ2d 1663, 1666 (Fed. Cir. 1996) ("[T]he mere possibility that one of the esters or the active methylene group-containing compounds... could be modified or replaced such that its use would lead to the specific sulfoalkylated resin recited in claim 8 does not make the process recited in claim 8 obvious 'unless the prior art suggested the desirability of [such a] modification' or replacement.") (quoting *In re Gordon*, 733 F.2d 900, 902, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984)). Applicants submit that the Office has not established the requisite motivation as to why one of ordinary skill in the art would have selected the specifically claimed alloy's components in the weight percents as claimed over any of the other possible combinations disclosed. A *prima facie* case for obviousness has therefore not been made.

Furthermore, as disclosed in Example 5, with reference to Figures 4 and 5, of Applicants' specification, claims 1, 3 and 4 include relatively low percentages of Rh. These alloys experience reduced oxidation weight loss in comparison to other alloys. For example, the weight loss of alloys 6 and 7 of Example 5 had weight losses approximately four times less than that for pure iridium and approached that which was found for a commercial 10 wt % Rh-Ir alloy. Such disclosure supports the nonobviousness of Applicants' claimed invention, where the cited references lack any suggestion or motivation as to why one of ordinary skill in the art, without Applicants' disclosure, would select the claimed alloys from among the many disclosed in the cited art.

Even under *KSR*, which has refined the test for obviousness, it would not be "obvious to try" by choosing from among the disclosed constituents to achieve Applicants' claimed alloy. None of the references disclose any reasonable expectation that the specifically claimed alloy would perform better than any of the other disclosed constituents, particularly in the concentrations claimed by Applicants. Nor has the Office provided any reason why one of ordinary skill in the art would be motivated to select the specifically claimed alloy from the broad disclosures of the references.

For at least these reasons, Applicants submit that independent claims 1, 3 and 4 are patentable over the cited references. Moreover, claims 2, 5-10 and 13-18 are also patentable over the cited references for at least the reasons that claims 1, 3 and 4 are patentable, but may be separately patentable for additional reasons as well.

#### **RESPONSE TO OBVIOUSNESS-TYPE DOUBLE PATENTING REJECTION**

The Office has rejected claims 1, 2, 6, 8, 9, 11, 12, and 16-18 on the grounds of nonstatutory obviousness-type double patenting as unpatentable over claims 1-16 of Orjela. Specifically, the Office asserts that although the conflicting claims are not identical, they are not patentably distinct because the pending claims disclose an iridium alloy for a spark plug electrode containing Rh, W and Zr in weight percent ranges that overlap the patented claims.

Applicants submit that the claims of Orjela are directed to an ignition device for an internal combustion engine, comprising such features as a housing, an insulator, a center electrode and a ground electrode, and also includes at least one electrode and a firing tip formed from an alloy containing iridium, rhodium, tungsten, and zirconium. The present application, in contrast, includes claims directed to an iridium alloy consisting essentially of iridium, rhodium, and at least one of tungsten and zirconium in specified concentrations as set forth in the claims. Applicants submit that although the pending rejected claims are directed to an iridium alloy having a composition that is inclusive of the alloy claimed in Orjela, because none of the pending claims are directed to an ignition device for an internal combustion engine including such features as a housing, an insulator, a center electrode and a ground electrode, the obviousness-type double patenting rejection is improper and must be withdrawn.

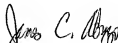
Appln. No.: 10,521,217  
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Reply to Office Action of July 24, 2007

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## CONCLUSION

In view of the amendments and arguments set forth above, Applicants respectfully submit that the application is in condition for allowance. Notice to this effect is earnestly solicited.

Respectfully submitted,



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Enclosures: Computer Translation of JP 10-259435  
Computer Translation of JP 6-112261

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JP10259435 IRIIDIUM BASE ALLOY

Date of publication of application : 29.09.1998

Application number : 09-117132

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Inventor : NISHIKAWA SATOSHI OMORI GORO

Abstract:

**PROBLEM TO BE SOLVED:** To provide an iridium base alloy excellent in high temp. strength required as a heat resistant material in the high temp. region of  $\approx 1100^{\circ}\text{C}$ , furthermore excellent in oxidation resistance in the temp. range of 800 to  $1050^{\circ}\text{C}$  in the air and moreover remarkably improved in expansibility required for attaining plastic workability to thin the material.

**SOLUTION:** To pure iridium as a base a secondary element composed of one kind among platinum, tantalum, rhodium, niobium, tantalum, hafnium, titanium, zirconium, yttrium, lanthanum and molybdenum is added in the solid solution range by 0.1 to 50 wt.% or several kinds of the secondary elements one compositely added in the solid solution range by 0.1 to 50 wt.%, to obtain the iridium base alloy which attains strength at low temps. and high temps. and, furthermore, improves oxidation resistance and expansibility at high temps.

[Claim(s)]

[Claim 1] iridium is used as the base -- platinum, palladium, a rhodium, niobium, a tantalum, a hafnium, titanium, a zirconium, an yttrium, a lanthanum, and molybdenum -- the iridium alloy which is dissolution within the limits about the second element which consists of any these one sorts, and is characterized by being dissolution within the limits and coming to carry out compound addition of addition or said second yuan prime factor kind.

[Claim 2] an iridium radical according to claim 1 -- setting -- platinum, palladium, a rhodium, niobium, a tantalum, a hafnium, titanium, a zirconium, an yttrium, a lanthanum, and molybdenum -- the addition of the second element which consists of any these one sorts -- or said second yuan prime factor kind of addition total amount -- respectively -- Iridium radical alloy characterized by holding down to dissolution [ 0.1 - 50wt% of ] within the limits.

[Claim 3] iridium is used as the base -- as the second element -- a rhodium -- adding -- further -- as the third element -- platinum, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- the iridium radical alloy which is dissolution within the limits, adds any these one sorts, and is characterized by the addition total amount of this third element and said second element being dissolution within the limits.

[Claim 4] an iridium alloy according to claim 3 -- setting -- rhodium of the second element 0.1 - 30wt% of within the limits -- adding -- further -- the platinum of the third element, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- any these one sorts -- dissolution [ 0.1 - 20wt% of ] within the limits -- it is -- adding -- addition total amount of this third element and said second element Iridium radical alloy characterized by being dissolution within the limits which is 0.2 - 50wt%.

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention relates to the heat-resisting material used for elevated-temperature devices, such as a energy development device, a space industrial use member, and crucible for the refractory material dissolution. As the concrete application, the gas turbine for a generation of electrical energy, a gas turbine blade, In a jet engine and a thermo-sensor list, personal-protective-equipment material and a semiconductor material, It is further related with the heat-resisting material with which reinforcement hot [ , such as crucibles for the refractory material dissolution, such as a charge of ceramic industry lumber and a single crystal mould material of a glass lens, glass dissolution equipment, or a chemical fiber nozzle, ], oxidation resistance, etc. are demanded, and the heat-resisting material used for burning-appliance structure material etc.

[0002]

[Description of the Prior Art] Conventionally, it is known that it is mainly a nickel radical alloy as this kind used for the gas turbine blade etc. of a heat-resisting material.

[0003]

[Problem(s) to be Solved by the Invention] By the way, the temperature which, as for a nickel radical alloy, can demonstrate the place the melting point of whose is 1300 degrees C of abbreviation to the reinforcement is about 1100 degrees C substantially, and 1100 degrees C is made into the operating critical temperature, i.e., durable temperature. Therefore, the activity in an elevated-temperature field 1100 degrees C or more of this nickel radical alloy becomes impossible.

[0004] Moreover, although a tantalum, niobium, molybdenum, a tungsten, platinum, pure iridium, etc. are known as a refractory material, as long as the refractory material which consists of an element of these kinds is used in a vacuum or an inert gas ambient atmosphere, reinforcement can be demonstrated by the pyrosphere to directly under [ melting point ], but in ambient atmospheres, such as inside of atmospheric air, and combustion gas, since oxidative consumption is carried out quickly, it cannot be used for the various applications mentioned above. by the way -- although the melting point is 2454 degrees C and a high refractory material when it sees paying attention to pure iridium -- since it is weak -- plasticity -- scarce -- for example, -- since it is very difficult to process it into about 0.5mm sheet metal, also restrict the application range -- \*\*\*\*\* Furthermore, the oxidative consumption in the inside of atmospheric air will be intense, for example, will be exhausted from oxidizing violently in a 800-1050-degree C temperature requirement, and sublimating as an oxide (Ir O<sub>2</sub> and Ir O<sub>3</sub>) into atmospheric air. However, if it becomes 1500 degrees C or more, since the oxide will be disassembled into a component, progress of oxidation can be suppressed. Therefore, since oxidative consumption of the refractory material which consists of pure iridium was carried out quickly in the 800-1050-degree C temperature requirement in atmospheric air and a combustion gas ambient atmosphere, it was a refractory material which lacks in practicability.

[0005] The place which this invention was made such conventionally in view of the situation, and is made into the object is excellent in the high temperature strength ( proof stress) demanded as a heat-resisting material in a pyrosphere 1100 degrees C or more, moreover is excellent in the oxidation resistance in the 800-1050-degree C temperature requirement in atmospheric air, and is to offer the iridium radical alloy with which the



plasticity demanded when raising further the workability which makes the thinning of an ingredient possible has been improved.

[0006]

[Means for Achieving the Goal]

the pure iridium from which this invention serves as the base in order to attain a technical problem -- platinum, palladium, a rhodium, niobium, a tantalum, a hafnium, titanium, a zirconium, an yttrium, a lanthanum, and molybdenum -- let it be a summary to come to carry out compound addition of the second element which consists of any these one sorts by dissolution within the limits (single phase) by dissolution within the limits (single phase) by addition or said second yuan prime factor kind. Moreover, the above-mentioned platinum, palladium, a rhodium, niobium, a tantalum, a hafnium, titanium, a zirconium, an yttrium, a lanthanum, and molybdenum -- addition of the second element which consists of any these one sorts By dissolution within the limits (single phase) which is 0.1 - 50wt% An addition total amount addition or said second yuan prime factor kind on the pure iridium used as the base Let it be a summary to come to carry out compound addition at the pure iridium used as the base by dissolution within the limits (single phase) which is 0.1 - 50wt%. Iridium is strengthened by solid-solution hardening with \*\*\*\* technical means. Moreover, the oxidation resistance of iridium is planned by generating the stability coat to oxidization hot [ 1500 degrees C or more ] on the surface of iridium.

[0007] furthermore, the pure iridium used as the base -- as the second element -- a rhodium -- adding -- further -- as the third element -- platinum, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- any these one sorts are added by dissolution within the limits (single phase), and let it be a summary for the addition total amount to the pure iridium of this third element and said second element to be dissolution within the limits (single phase). an alloy configuration -- rhodium of the second element of the above 0.1 - 30wt% of within the limits -- adding -- further -- the platinum of the third element, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- any these one sorts 0.1 - 20wt% of within the limits -- adding -- addition total amount of this third element and said second element Let it be a summary to have held down to dissolution [ 0.2 - 50wt% of ] within the limits (single phase). the second element which consists of a rhodium according to the \*\*\*\* technical means and platinum, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- the stability coat which was excellent in oxidation resistance on the surface of iridium with the addition in dissolution within the limits of the third element which consists of any these one sorts is generated. Thereby, oxidative consumption is the most intense in atmospheric air and a combustion gas ambient atmosphere. While being able to suppress extremely the oxidization consumption in 800-1050 degrees C, solid-solution hardening is brought about and iridium is strengthened. Furthermore, the plasticity which viscosity has also been improved and was excellent is acquired.

[0008]

[Embodiment of the Invention] The example of operation of this invention is explained based on a drawing. The graph which showed the effect of the second element which drawing 1 is an example of this invention iridium radical alloy concerning claim 1 thru/or 2, and is exerted on the hardness of iridium, Drawing 2 is the graph which showed the weight change accompanying the passage of time in a 1500-degree C exposure test, and is set to \*\*\*\* this invention. Platinum (Pt), palladium (Pd) to the pure iridium (Ir) used as the base, A rhodium (Rh), niobium (Nb), a tantalum (Ta), a hafnium (Hf), Titanium (Ti), a zirconium (Zr), an yttrium (Y), a lanthanum (La), molybdenum (Mo) -- addition of the second element which consists of any these one sorts dissolution [ 0.1 - 50wt% of ] within the limits (single

phase) -- or said second yuan prime factor kind of addition total amount The need has held down to dissolution [ 0.1 - 50wt% of ] within the limits (single phase). The addition of the second element or the addition total amount of the second yuan prime factor kind the reason in less than [ 0.1wt% ], an anti-oxidation property, solid-solution hardenability, and viscosity are not improved, and plasticity (strip-processing nature) is not different from that of pure iridium in an anti-oxidation property list, that is, it is because the property of iridium is not improved. It is from on the other hand, causing the result to which it deposits, and the 2nd phase (intermetallic compound) carries out precipitation hardening, and is inferior to which also in about [ that plastic working becomes difficult ] and acid-proof \*\*\*\*, if the alloying element to pure iridium crosses the dissolution range.

[0009] therefore, platinum [ as opposed to pure iridium at this invention ], palladium, a rhodium, niobium, a tantalum, a hafnium, titanium, a zirconium, an yttrium, a lanthanum, and molybdenum -- addition of the second element which consists of any these one sorts Addition total amount of these [ dissolution / 0.1 - 50wt% of / within the limits (single phase), or ] second yuan prime factor kind It is desirable to consider as dissolution [ 0.1 - 50wt% of ] within the limits (single phase). The inside of various kinds of second elements especially mentioned above, platinum (Pt), palladium (Pd), The niobium (Nb) except a rhodium (Rh), a tantalum (Ta), a hafnium (Hf), titanium (Ti), a zirconium (Zr), an yttrium (Y), a lanthanum (La), and molybdenum (Mo) -- if it is in the second element which consists of any these one sorts -- the addition -- less than [ 10wt% ] -- or it is desirable to hold down the addition total amount of these second yuan prime factor kind to less than [ 10wt% ].

[0010] every of the niobium and the hafnium with which the independent addition of the addition was made to be carried out by dissolution within the limits not more than 10wt% (single phase) to example 1 pure iridium here, an yttrium, a tantalum, and molybdenum -- specified quantity \*\*\*\* of the second element was carried out, and it ingoted with the arc solution process. Ir-Nb, Ir-Hf, Ir-Y, Ir-Ta, and Ir-Mo which were obtained by this -- after cutting the ingot of the shape of a carbon button of each alloy of these into the test piece of phi5mm and the shape of a cylinder with a height of 5mm by the wire cutting method and giving surface \*\*\*\* by the diamond file, the mechanical property (proof stress) of strength etc. was investigated. As mechanical characteristics of these alloys, Vickers hardness number is investigated and the result is illustrated to drawing 1. Furthermore, a malleability test investigates deformation resistance hot [ accompanying addition of the second element ], and the result is illustrated to a table 1 as a deformation resistance value accompanying addition of the second element.

[0011] Although hardness shows solid-solution hardening which becomes high while the addition (dissolution concentration) of any alloy system of the second element increases so that clearly from drawing 1, it turns out that the large thing of especially hardenability is the alloy system obtained by addition of niobium and a hafnium. And it turns out that as high a deformation resistance value as the addition of the second element increasing (dissolution concentration being high) is shown so that clearly from a table 1. That is, it is shown that reinforcement becomes high, so that the addition of each element increases also in that pure iridium is strengthened by solid-solution hardening and an elevated temperature. Therefore, as for the iridium radical alloy obtained by this example, it became clear low temperature and to excel in the mechanical property (proof stress) of strength etc. also in an elevated temperature further.

[0012] The addition to example 2 pure iridium carried out specified quantity \*\*\*\* of each second element of the niobium which is dissolution within the limits not more than 1wt%,

and was added, a hafnium, a tantalum, and molybdenum, and ingoted with the arc solution process. Ir-Nb, Ir-Hf, Ir-Ta, and Ir-Mo which were obtained by this -- oxidation resistance was investigated, after cutting the ingot of the shape of a carbon button of each alloy of these into the test piece of the shape of a cylinder mentioned above by the wire cutting method and giving surface \*\*\*\* by the diamond file. This oxidation resistance investigated that hardness change in the surface state of the test piece after carrying out predetermined time exposure of the test piece all over the furnace heated at 1500 degrees C, weight change, and a list. The result is illustrated to drawing 2 .

[0013] Ir-Nb, Ir-Hf, Ir-Ta, and Ir-Mo in which oxidation resistance was excellent compared with pure iridium so that clearly from drawing 2 -- although the alloy system of these shows the increase of weight and decreases after that for a short time, it turns out that the change is as small as an alloy excellent in oxidation resistance. That is, the stability coat to oxidization is generated by the front face, and the oxidation resistance of pure iridium is improved. Therefore, it became clear that the iridium radical alloy obtained by this example has the oxidation resistance which was excellent in the elevated temperature. In addition, although not shown in drawing, as for the case of the molybdenum addition to pure iridium, oxidation resistance is greatly improved for an addition about abbreviation 5wt%.

[0014] addition to example 3 pure iridium the palladium which is dissolution within the limits which is 0.1 - 5wt%, and was added, a tantalum, a lanthanum, and titanium -- every of these -- specified quantity \*\*\*\* of the second element was carried out, and it ingoted with the arc solution process. Ir-Pd, Ir-Ta, Ir-La, and Ir-Ti which were obtained by this -- plasticity was investigated, after cutting the alloy (ingot) of these into the test piece of the shape of a cylinder mentioned above by the wire cutting method and giving surface \*\*\*\* by the diamond file. The deformation resistance accompanying the addition of the second element and change of temperature investigated this plasticity. The result is illustrated to a table 2 as a deformation resistance value accompanying change of temperature at table 1 list.

[0015] It turns out that as low a deformation resistance value as there being few additions of the second element (dissolution concentration being low) is shown so that clearly from a table 1. And it turns out that such a low deformation resistance value is shown that temperature becomes high even if the addition of the second element increases so that clearly from a table 2. That is, the addition of the second element is stopped and the plasticity which was excellent when performing plastic working within the temperature (1250 degrees C of abbreviation) which does not cause secondary recrystallization (big-and-rough-izing of crystal grain) is shown. therefore, the iridium radical obtained by this example -- duality -- it became clear to excel also in the plasticity demanded when a system alloy raises workability.

[0016]  
[table 1]

Addition of second element and high temperature flow stress

高温における第二元素の添加に伴う変形抵抗

合 金	試験温度 (°C)	変形抵抗値 (kg/mm <sup>2</sup> )
I r - 1 % P d	1 2 0 0	4 8 . 1 8
I r - 5 % P d	1 2 0 0	5 1 . 6 8
I r - 1 % T a	1 2 0 0	5 0 . 1 3
I r - 5 % T a	1 2 0 0	5 1 . 9 2
I r - 1 % L a	1 2 0 0	5 7 . 7 7
I r - 5 % L a	1 2 0 0	6 5 . 7 6
I r - 1 % T i	1 2 0 0	8 3 . 3 0

[0017]

[table 2]

High temperature resistance to deformation

温度の変化に伴う変形抵抗

合 金	試験 温度 (°C)	変形抵抗値 (kg/mm <sup>2</sup> )
I r - 5% P d	1 0 0 0	6 1. 2 4
I r - 5% P d	1 2 0 0	5 1. 6 8
I r - 5% P d	1 4 0 0	4 3. 4 4
I r - 5% T a	1 0 0 0	6 2. 0 0
I r - 5% T a	1 2 0 0	5 1. 9 2
I r - 5% T a	1 4 0 0	4 3. 4 8

[0018] As described above, according to the iridium radical alloy of this invention concerning claim 1 thru/or 2, by solid-solution hardening being shown with the second element to add, it is common, but it turns out that the effects which it has with the class, and the addition (wt%) or an addition total amount (wt%) of the second element added about hardenability, high temperature strength (proof stress), oxidation resistance, and plasticity differ.

[0019] Drawing 3 is an example of this invention iridium radical ternary alloy concerning claim 3 thru/or 4. The graph which showed the relation of the workability (%) until a crack is macroscopically accepted in the side face of rolled stock and the addition total amount (wt%) to pure iridium (Ir) at the time of hot-rolling in the condition of having heated at 1200 degrees C. The oxidative consumption of pure iridium is the graph which showed the relation of the amount of oxidative consumption and exposure time in 1050 degrees C which becomes the most intense, and drawing 4 is set to \*\*\*\* this invention. On the pure iridium (Ir) used as the base, a rhodium (Rh) is added as the second element. Furthermore, as the third element, platinum (Pt), a ruthenium (Ru), a rhenium (Re), chromium (Cr), vanadium (V), and molybdenum (Mo) -- by adding any these one sorts by dissolution within the limits (single phase), and making the third element permute said a part of second element For example, it excels in oxidation resistance hot [ 1050-degree C ], and the ternary alloy with which the plasticity demanded when raising workability moreover has been improved is ingoted.

[0020] And addition of the second element which consists of a rhodium to the pure iridium which serves as the base in this invention To 0.1 - 30wt% of within the limits furthermore, platinum, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- addition of the third element which consists of any these one sorts To dissolution [ 0.1 - 20wt% of ] within the limits (single phase) And the total addition of the third element and the second element To stop, respectively is required for dissolution [ 0.2 - 50wt% of ] within the limits (single phase). The addition of the second element this reason in less than [ 0.1wt% ], oxidation resistance, solid-solution hardenability, and viscosity are not improved, and

thermal resistance and plasticity are not different from pure iridium, that is, it is because the property of iridium is not improved. It is because plasticity will worsen on the other hand if it becomes more than 30wt%. Moreover, the addition of the third element in less than [ 0.1wt% ], it is because an anti-oxidation property, solid-solution hardenability, and each viscous improvement effect are small as mentioned above. If it becomes more than 20wt% on the other hand -- the 2nd phase (intermetallic compound) -- depositing -- being easy -- it is because plasticity worsens at an oxidation-resistant list. And the total addition to the pure iridium of the third element and the second element in less than [ 0.2wt% ], it is because solid-solution hardenability is small and an anti-oxidation property and plasticity do not change it so much to it of pure iridium, either. It is because the 2nd phase (intermetallic compound) will deposit and plasticity will also worsen on the other hand at an anti-oxidation property list, if it becomes more than 50wt%.

[0021] Therefore, addition of the rhodium of the second element to the pure iridium which serves as the base in this invention To 0.1 - 30wt% of within the limits the platinum of the third element, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- any these one sorts of additions To dissolution [ 0.1 - 20wt% of ] within the limits (single phase) And addition total amount of the third element and said second element It is desirable to hold down to dissolution [ 0.2 - 50wt% of ] within the limits (single phase):

[0022] On the pure iridium used as the base, as the second element, a 15wt(s)% rhodium The Ir-15Rh-15Pt system alloy which \*\*\*\*(ed) so that the addition total amount of this third element and said second element might furthermore become 30wt(s)% to pure iridium including 15wt(s)% platinum as the third element, On the pure iridium used as the base, as the second element Moreover, rhodium 2wt%, The Ir-2Rh-3Ru system alloy which \*\*\*\*(ed) so that ruthenium 3wt% might be added as the third element, respectively and the addition total amount of both the element might become 5wt(s)%, On the pure iridium used as the base, as the second element Moreover, rhodium 2wt%, The ternary alloy of these is prepared. The Ir-2Rh-3Ru system alloy which \*\*\*\*(ed) so that rhenium 3wt% might be added as the third element, respectively and the addition total amount of both the element might become 5wt(s)% -- The ingot ingoted in the shape of a carbon button with the argon arc solution process is set in atmospheric air. Between heat or warm working, For example, it is an one pass in the condition of having heated at 1200 thru/ or 1300 degrees C. It hot-rolls by 0.1% of reduction of sectional area. Plasticity is evaluated in quest of workability (%) until crack generating macroscopically accepted in the rolled stock side face accompanying rolling arises, and board thickness after that 0.5 to 0.01 mm The strip-processing nature was investigated performing strip processing until it resulted [ from the sheet metal which is extent ] in the foil. The result is illustrated to drawing 3 . Moreover, the board thickness obtained by this hot working Using the sheet metal which is 0.5mm, oxidative consumption chooses 1050 degrees C in the atmospheric air which becomes the most intense, investigates the amount of oxidative consumption by 20 hours, and illustrates that result to drawing 4 .

[0023] On the pure iridium used as the base, as the second element Moreover, rhodium 10wt%, The Ir-10Rh-1Mo system alloy which \*\*\*\*(ed) so that molybdenum 1wt% might be added as the third element, respectively and the addition total amount of both the element might become 11wt(s)% to pure iridium, On the pure iridium used as the base, as the second element Moreover, rhodium 2wt%, The Ir-2Rh-3Cr system alloy which \*\*\*\*(ed) so that chromium 3wt% might be added as the third element, respectively and the addition total amount of both the element might become 5wt(s)%, On the pure iridium used as the base, as the second element Moreover, rhodium 2wt%, The ternary alloy of these is prepared. the Ir-2Rh-3V system alloy which \*\*\*\*(ed) so that vanadium 3wt% might be

added as the third element, respectively and the addition total amount of both the element might become 5wt(s)% -- Also in the plasticity by hot rolling in the condition of having heated at 1200 thru/or 1300 degrees C in the atmospheric air which mentioned above the ingot ingoted in the shape of a carbon button with the argon arc solution process, and the amount of oxidative consumption in 1050 degrees C, to which oxidation becomes the most intense into atmospheric air, it investigated, respectively.

[0024] The workability (%) to crack generating of each alloy of a ternary system is understood that strip processing until it is improved rather than pure iridium and results [ from sheet metal ] in a foil is possible so that clearly from drawing 3 . That is, it became clear to excel in the plasticity demanded when viscosity is improved and each iridium radical ternary alloy obtained by this example raises workability. Moreover, although pure iridium has intense oxidative consumption so that clearly from drawing 4 , as for all the obtained ternary alloy, it turns out that oxidative consumption is stopped. That is, the stability coat to oxidization is generated by the front face, and the oxidation resistance of pure iridium is improved. Therefore, it became clear that the iridium radical ternary alloy obtained by this example has the outstanding oxidation resistance with which progress of oxidation in the temperature requirement especially whose oxidative consumption is most intense 1050 degrees C was suppressed in atmospheric air.

[0025] Therefore, the Ir-15Rh-15Pt system alloy obtained by this invention concerning claim 3 thru/or 4, An Ir-10Rh-1Mo system alloy, an Ir-2Rh-3Ru system alloy, an Ir-2Rh-3Ru system alloy, An Ir-2Rh-3Cr system alloy, an Ir-2Rh-3V system alloy, and all the iridium radical ternary alloy of these It became clear to excel in the plasticity demanded when raising the workability in the condition of having heated at 1200 thru/or 1300 degrees C in atmospheric air, and to excel in the oxidation resistance in 1050 degrees C to which the oxidative consumption of pure iridium moreover becomes the most intense into atmospheric air.

[0026]

[Effect of the Invention] Since it comes to constitute the iridium radical alloy of this invention like the above statement, It does the following operation effectiveness so.

\*\* . Since it excels in the reinforcement (proof stress) hot [ which is known from the former ] demanded as a heat-resisting material in a pyrosphere 1100 degrees C or more, and oxidation resistance even if it compares with a nickel radical alloy, for example, the thinning by improvement in energy efficiency and the consolidation of an ingredient and a miniaturization are expectable. therefore, the iridium radical of this invention concerning claim 1 thru/or 2 -- duality -- according to the system alloy, the thinning by the improvement in energy efficiency and the consolidation of an ingredient, miniaturization of a device, and extension of a life are achieved. And since plasticity is excellent, plastic working can become easy, the escape of the application range as expansion material can be expected, and useful and practical effectiveness can be expected greatly. Furthermore, in the conventional heat-resisting material, since the application beyond the temperature of 1100 degrees C or more which was not able to be used opens, much effectiveness, like the economical effectiveness by the escape of the application range is also large is expectable.

[0027] \*\* . It sets in atmospheric air or a combustion gas ambient atmosphere, and oxidation consumption becomes the most intense. The property of the pure iridium in 800-1050 degrees C Addition of the rhodium of the second element and the platinum of the third element, a ruthenium, a rhenium, The addition in any these 1 sorts of dissolution within the limits (single phase) improves greatly. chromium, vanadium, and molybdenum --

It excels also in the hot oxidation resistance demanded as a heat-resisting material in a pyrosphere 1100 degrees C or more, and the iridium radical ternary alloy of the solid-solution hardening mould excellent in plasticity is obtained. Therefore, since it excels in oxidation resistance iridium radical ternary alloy \*\*\*\*\* of this invention concerning claim 3 thru/or 4, and hot [ 800-1050-degree C ], the escape of the application range as a heat-resisting material is expectable, and the oxidation resistance as a heat-resisting material -- in addition, since it excels also in the plasticity demanded when planning plastic working, the thinning of an ingredient is expectable. For example, board thickness 0.5 to 0.01 mm It becomes processible [ from the sheet metal which is extent to a foil ]. Therefore, since the escape of the application range as expansion material is also expectable, much effectiveness, like expectation of the economical effectiveness by the escape of the application range is great is also expectable.



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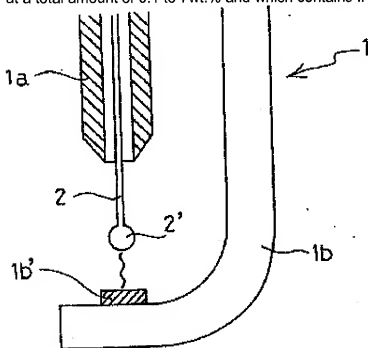
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Abstract

**PURPOSE:**To provide an automatic wire bonder by which an irregularity in a ball diameter is small when a ball is formed by making an electric discharge from a discharging electrode more stable.

**CONSTITUTION:**A discharging electrode 1a and its head part 1b are formed of an Ir alloy which contains one kind or two or more kinds out of Os, Ru, Pt, Rh and Pd at a total amount of 1 to 30wt.%, which contains one kind or two or more kinds out of Re, W and Mo at a total amount of 0.1 to 7wt.% and which contains Ir as the remainder.



[Claim(s)]

[Claim 1] the discharge electrode for ball formation at the time of bonding -- one or more of Os, Ru, Pt, Rh, and Pd - total amount 1 - 30wt% - remainder Ir and the automatic wire bonder characterized by this alloy.

[Claim 2] the discharge electrode for ball formation at the time of bonding --one or more of Os, Ru, Pt, Rh, and Pd - total amount 1 - 30wt% - while also containing -- one or more of Re, W, and Mo - total amount 0.1 - 7wt% -remainder Ir, and the automatic wire bonder characterized by using this Ir alloy.

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the discharge electrode for ball formation in said wire bonder in more detail about the automatic wire bonder used in order to connect the chip electrode of a semiconductor device, and an external lead.

[0002]

[Description of the Prior Art] As shown in drawing 1 from the former, carry out melting of the head of the Au line 2 which made it hang at the head of capillary tube 1a by discharge from head head section 1b' of discharge electrode 1b, and ball 2' is formed. The bump continuation which sticks by pressure and cuts this ball 2' at the electrode which consists of aluminum or aluminum alloy on a chip, and forms a bump electrode. After sticking said ball 2' to a chip electrode by pressure and making it join, it leads to an external lead in the shape of a loop formation, and the wirebonding method for connecting a chip electrode and an external lead to this external lead by sticking by pressure and cutting is learned.

[0003] Moreover, what added a small amount of impurity to refractory metals, such as W-Y and W-La, as a useful automatic wire bonder 1, and formed discharge electrode 1b for using for this bonding method is known (JP,1-256134,A).

[0004]

[Problem(s) to be Solved by the Invention]

However, in the wire bonder of the above-mentioned method, W-Y and W-La tended to oxidize, and since an oxide skin is formed in a discharge electrode front face, as a result of discharge becoming unstable and dispersion's arising in the diameter of a ball formed, there was nonconformity to which the connection resilience after bonding becomes low.

[0005] This invention is made in view of a situation such conventionally, and the place made into the object is to reduce dispersion in the diameter of the ball [ discharge / from a discharge electrode ] at the time of ball formation as a more stable thing.

[0006]

[Means for Solving the Problem] the discharge electrode for the bonder of this invention formation at the time of bonding in order to attain the above object -- one sort out of Os, Ru, Pt, Rh, and Pd, or two sorts or more -- total amount 1 - 30wt% -- it contains and is characterized by being Ir alloy which consists of the remainder Ir.

[0007] moreover, the below-mentioned reason to said discharge electrode -- one sort out of Os, Ru, Pt, Rh, and Pd, or two sorts or more -- total amount 1 - 30wt% -- while containing -- one sort out of Re, W, and Mo, or two sorts or more -- total amount 0.1 - 7wt% -- it is good that it is also Ir alloy which contains and consists of the remainder Ir.

[0008]

[Function] According to the above-mentioned configuration, since it evaporates at about 400 degrees C even if it oxidizes, an oxide film is not formed in the discharge electrode front face which becomes an elevated temperature (about 3000 degrees C) at the time of discharge, but Ir alloy which comes to add Os, Ru, Pt, Rh, and Pd, and Ir alloy which comes to add Re, W, and Mo in addition to the aforementioned combination become that by which the discharge from this electrode was stabilized. therefore, dispersion of the diameter of a ball -- very -- small -- it considers as a range thing and the connection resilience after bonding can be improved.

[0009] Moreover, since the discharge electrode became an elevated temperature at the time of discharge, it chose what is high-melting to the alloying element which forms Ir alloy, i.e., Os, Ru, Pt, Rh, and Pd. Furthermore, improvement in the workability at the time of electrode production could be aimed at by carrying out simultaneous adding of at least one sort out of Re, W, and Mo.

[0010] However, since a segregation will arise and Ir alloy will become uneven if high temperature strength and the addition total amount of Os, Ru, Pt, Rh, and Pd satisfactory less than [ 1wt% ] is not obtained and the addition total amount of Os, Ru, Pt, Rh, and Pd exceeds 30wt(s)%, it is not desirable.

[0011] Furthermore, if the above-mentioned effectiveness cannot be acquired if the addition total amount of Re, W, and Mo is less than [ 0.1wt% ], and the addition total amount of these alloying elements exceeds 7wt(s)%, since Ir alloy will become uneven, it is not desirable.

[0012] Therefore, the total addition of Os, Ru, Pt, Rh, and Pd was set as the range of 1 - 30wt%, and the total addition of Re, W, and Mo was respectively set as the range of 0.1 - 7wt%.

[0013]

[Example] Hereafter, a concrete example and the example of a comparison are explained. Os, Ru, Pt, Rh, Pd, Re, W, and Mo were added based on the content shown in a table 1, dissolution casting was carried out, and it considered as each sample at Ir of 99.9% or more of purity.

[0014] Sample No.1-10 in a table 1 Os, Ru, Pt, Rh, Pd this invention operation article which added one sort out of (calling it an alloying element I hereafter), They are this invention operation article which added one sort out of Re, W, and Mo (henceforth an alloying element II) in addition to combination of the above [ sample NO.11-16 ], and this invention operation article which sample No.17-22 chose two or more sorts, and added out of said alloying element I.

[0015] Moreover, sample No.23 in a table 1 are a comparison article it is unrefined from a W-Y alloy.

[0016] The automatic wire bonder 1 was constituted for discharge electrode 1b as shown in drawing 1, and its head section 1b' with shaping \*\*\*\* using each sample produced as mentioned above. Then, the discharge current was adjusted so that it might fix to 4ms of charging time values and might become 62.5 micrometers of diameters of a ball using Au wire (phi25micrometer) generally used, and the average and standard deviation of the diameter of a ball at the time of producing ten balls after 50,000 times discharge were measured respectively. These results are also shown in a table 1.

[0017]

[Table 1]

A=Example/Alloy No B=Alloy addition (Rest is Ir) C=ball diameter

A

B

C

試 品 No	I r	添 加 元 素 ( wt% )								ボール径 ( $\mu$ m )	
		Os	Ru	Pt	Rh	Pd	Re	W	Mo	平 均 値	標準偏差
実	1	残り	1							62.65	0.624
	2	↑	30							62.59	0.611
	3	↑		1						62.73	0.782
	4	↑		30						62.66	0.721
	5	↑			1					62.49	0.651
	6	↑			30					62.53	0.712
	7	↑				1				62.61	0.810
	8	↑				30				62.58	0.773
	9	↑					1			62.67	0.785
	10	↑					30			62.71	0.803
施	11	↑	10				0.1			62.59	0.620
	12	↑	10					7		62.51	0.609
	13	↑		10				0.1		62.53	0.612
	14	↑		10					7	62.60	0.603
	15	↑			10				0.1	62.71	0.731
	16	↑			10				7	62.69	0.689
	17	↑		15	15					62.56	0.633
	18	↑			20		10			62.48	0.610
	19	↑	10				20			62.44	0.652
	20	↑		10	10		10			62.61	0.601
品	21	↑	5	5	5		5			62.50	0.644
	22	↑	5	5	5		5			62.53	0.635
*	23									62.83	1.163

\* : 比較品

[0018] if it \*\*, and an alloying element I (Os, Ru, Pt, Rh, Pd) is added to Ir of 99.9% or more of purity by total addition 1 - 30wt% of within the limits and an alloying element II (Re,

W, Mo) is further added from the measurement result of sample No.1-22 by total addition 0.1 - 7wt% of within the limits -- dispersion in the diameter of a ball -- very -- small -- it has checked that it could consider as a range thing.

[0019] Moreover, when the discharge electrode which consists of a W-Y alloy was used from the measurement result of sample No.23, as compared with the above-mentioned this invention operation article, it has checked that dispersion in the diameter of a ball was very large.

[0020] In addition, although both were really fabricated by each above-mentioned sample in this example by using discharge electrode 1b and head section 1b' as a moldings, it is also possible only for head section 1b' to fabricate them by each above-mentioned sample, using these both as another \*\*\*\*, and it cannot be overemphasized that the same measurement result as \*\*\*\* and effectiveness are acquired also in this case.

[0021]  
[Effect of the Invention] dispersion in the diameter of the ball [ the automatic wire bonder concerning this invention is using the discharge electrode which consists of an Ir alloy which carried out specified quantity addition of Os, Ru, Pt, Rh, Pd, Re, W, and the Mo, as explained above and ] at the time of ball shaping -- very -- small -- it could consider as the range thing.

[0022] Therefore, the ball after bonding and the bonding strength of a chip electrode have been improved remarkably, and the very useful automatic wire bonder has been offered for using for the wirebonding method and bump continuation.